



SEQUENCE LISTING

B2
<110> California Institute of Technology;
Frances H. Arnold
Hyun Joo

<120> Oxygenase Enzymes and Screening Method

<130> 9373/1E827-US1

<140> US 09/246,451

<141> 2000-09-02

<150> US 60/094,403

<151> 1998-07-28

<150> US 60/106,840

<151> 1998-11-03

<150> US 60/086,206

<151> 1998-05-21

<150> US 60/106,834

<151> 1998-11-03

<160> 19 ✓

<170> FastSEQ for Windows Version 3.0

<210> 1

<211> 1402

<212> DNA

<213> P. Putida

<400> 1

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| agcaaggcac | ttgaactggt | caaggcagga | gcactgatca | aaccggtgat | cgactccact | 120 |
| ctttagccaa | cccgcgttcc | aggagaacaa | caacaatgac | gactgaaacc | atacaaagca | 180 |
| acgccaatct | tgcccctctg | ccaccccatg | tgccagagca | cctgggtattc | gacttcgaca | 240 |
| tgtacaatcc | gtcgaatctg | tctgcccggc | tgcaggaggc | ctgggcagtt | ctgcaagaat | 300 |
| caaacgtacc | ggatctgggt | tggactcgct | gcaacggcgg | acactggatc | gccactcgcg | 360 |
| gccaactgat | ccgtgaggcc | tatgaagatt | accgccactt | ttccagcgag | tgcccgttca | 420 |
| tccctcgtga | agccggcgaa | gcctacgact | tcattcccac | ctcgatggat | ccgcccagac | 480 |
| agcgccagtt | tcgtgcgctg | gccaaccaag | tggttggtat | gcccgtgggtg | gataagctgg | 540 |
| agaaccggat | ccaggagctg | gcctgctcgc | tgatcgagag | cctgcgcccg | caaggacagt | 600 |
| gcaacttcac | cgaggactac | gccgaaccct | tcccgatacg | catcttcagt | ctgctcgcag | 660 |
| gtctaccgga | agaagatata | ccgcacttga | aatacctaac | ggatcagatc | accggtccgg | 720 |
| atggcagcat | gaccttcgca | gaggccaagg | aggcgctcta | cgactatctg | ataccgatca | 780 |
| tcgagcaacg | caggcagaag | ccgggaaccg | acgctatcag | catcgttgcc | aacggccagg | 840 |
| tcaatgggcg | accgatcacc | agtgcgaag | ccaagaggat | gtgtggcctg | ttactggtcg | 900 |
| gcggcctgga | tacggtgggtc | aatttcctca | gcttcagcat | ggagttcctg | gccaaaagcc | 960 |

12

| | | | | | | |
|-------------|------------|------------|-------------|------------|------------|------|
| cggagcatcg | ccaggagctg | atcgagcgtc | ccgagcggtat | tccagccgct | tgcgaggaac | 1020 |
| tactccggcg | cttctcgctg | ggtgccgatg | gccgcatact | cacctccgat | tacgagtttc | 1080 |
| atggcggtgca | actgaagaaa | ggtgaccaga | tctgtctacc | gcagatgctg | tctggcctgg | 1140 |
| atgagcgcgga | aaacgcctgc | ccgatgcacg | tcgacttcag | tcgccaaaag | gtttcacaca | 1200 |
| ccacctttgg | ccacggcagc | catctgtgcc | ttggccagca | cctggcccgc | cgggaaatca | 1260 |
| tcgtcacctt | caaggaatgg | ctgaccagga | ttcctgactt | ctccattgcc | cggggtgccc | 1320 |
| agattcagca | caagagcggc | atcgtcagcg | gcgtgcaggc | actccctctg | gtctgggatc | 1380 |
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<210> 2
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 <212> PRT
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<400> 2

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| Thr | Thr | Glu | Thr | Ile | Gln | Ser | Asn | Ala | Asn | Leu | Ala | Pro | Leu | Pro | Pro | |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | | |
| His | Val | Pro | Glu | His | Leu | Val | Phe | Asp | Phe | Asp | Met | Tyr | Asn | Pro | Ser | |
| | | | 20 | | | | | 25 | | | | | 30 | | | |
| Asn | Leu | Ser | Ala | Gly | Val | Gln | Glu | Ala | Trp | Ala | Val | Leu | Gln | Glu | Ser | |
| | | 35 | | | | | 40 | | | | | 45 | | | | |
| Asn | Val | Pro | Asp | Leu | Val | Trp | Thr | Arg | Cys | Asn | Gly | Gly | His | Trp | Ile | |
| | 50 | | | | | 55 | | | | | 60 | | | | | |
| Ala | Thr | Arg | Gly | Gln | Leu | Ile | Arg | Glu | Ala | Tyr | Glu | Asp | Tyr | Arg | His | |
| 65 | | | | | 70 | | | | | 75 | | | | | 80 | |
| Phe | Ser | Ser | Glu | Cys | Pro | Phe | Ile | Pro | Arg | Glu | Ala | Gly | Glu | Ala | Tyr | |
| | | | | 85 | | | | | 90 | | | | | 95 | | |
| Asp | Phe | Ile | Pro | Thr | Ser | Met | Asp | Pro | Pro | Glu | Gln | Arg | Gln | Phe | Arg | |
| | | | 100 | | | | | 105 | | | | | | 110 | | |
| Ala | Leu | Ala | Asn | Gln | Val | Val | Gly | Met | Pro | Val | Val | Asp | Lys | Leu | Glu | |
| | | 115 | | | | | 120 | | | | | 125 | | | | |
| Asn | Arg | Ile | Gln | Glu | Leu | Ala | Cys | Ser | Leu | Ile | Glu | Ser | Leu | Arg | Pro | |
| | 130 | | | | | 135 | | | | | 140 | | | | | |
| Gln | Gly | Gln | Cys | Asn | Phe | Thr | Glu | Asp | Tyr | Ala | Glu | Pro | Phe | Pro | Ile | |
| 145 | | | | | 150 | | | | | 155 | | | | | 160 | |
| Arg | Ile | Phe | Met | Leu | Leu | Ala | Gly | Leu | Pro | Glu | Glu | Asp | Ile | Pro | His | |
| | | | | 165 | | | | | 170 | | | | | 175 | | |
| Leu | Lys | Tyr | Leu | Thr | Asp | Gln | Met | Thr | Arg | Pro | Asp | Gly | Ser | Met | Thr | |
| | | | 180 | | | | | 185 | | | | | 190 | | | |
| Phe | Ala | Glu | Ala | Lys | Glu | Ala | Leu | Tyr | Asp | Tyr | Leu | Ile | Pro | Ile | Ile | |
| | 195 | | | | | | 200 | | | | | 205 | | | | |
| Glu | Gln | Arg | Arg | Gln | Lys | Pro | Gly | Thr | Asp | Ala | Ile | Ser | Ile | Val | Ala | |
| | 210 | | | | | 215 | | | | | 220 | | | | | |
| Asn | Gly | Gln | Val | Asn | Gly | Arg | Pro | Ile | Thr | Ser | Asp | Glu | Ala | Lys | Arg | |
| 225 | | | | | 230 | | | | | 235 | | | | | 240 | |
| Met | Cys | Gly | Leu | Leu | Leu | Val | Gly | Gly | Leu | Asp | Thr | Val | Val | Asn | Phe | |
| | | | | 245 | | | | | 250 | | | | | 255 | | |
| Leu | Ser | Phe | Ser | Met | Glu | Phe | Leu | Ala | Lys | Ser | Pro | Glu | His | Arg | Gln | |
| | | | 260 | | | | | 265 | | | | | 270 | | | |
| Glu | Leu | Ile | Glu | Arg | Pro | Glu | Arg | Ile | Pro | Ala | Ala | Cys | Glu | Glu | Leu | |
| | 275 | | | | | 280 | | | | | 285 | | | | | |
| Leu | Arg | Arg | Phe | Ser | Leu | Val | Ala | Asp | Gly | Arg | Ile | Leu | Thr | Ser | Asp | |
| | 290 | | | | | 295 | | | | | 300 | | | | | |

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| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Tyr | Glu | Phe | His | Gly | Val | Gln | Leu | Lys | Lys | Gly | Asp | Gln | Ile | Leu | Leu |
| 305 | | | | | 310 | | | | | 315 | | | | | 320 |
| Pro | Gln | Met | Leu | Ser | Gly | Leu | Asp | Glu | Arg | Glu | Asn | Ala | Cys | Pro | Met |
| | | | | 325 | | | | | 330 | | | | | 335 | |
| His | Val | Asp | Phe | Ser | Arg | Gln | Lys | Val | Ser | His | Thr | Thr | Phe | Gly | His |
| | | | 340 | | | | | 345 | | | | | 350 | | |
| Gly | Ser | His | Leu | Cys | Leu | Gly | Gln | His | Leu | Ala | Arg | Arg | Glu | Ile | Ile |
| | | 355 | | | | | 360 | | | | | 365 | | | |
| Val | Thr | Leu | Lys | Glu | Trp | Leu | Thr | Arg | Ile | Pro | Asp | Phe | Ser | Ile | Ala |
| | 370 | | | | | 375 | | | | | 380 | | | | |
| Pro | Gly | Ala | Gln | Ile | Gln | His | Lys | Ser | Gly | Ile | Val | Ser | Gly | Val | Gln |
| 385 | | | | | 390 | | | | | 395 | | | | | 400 |
| Ala | Leu | Pro | Leu | Val | Trp | Asp | Pro | Ala | Thr | Thr | Lys | Ala | Val | | |
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<220>
 <223> Primer sequence

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32

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 <211> 27
 <212> DNA
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27

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Bz

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B2

<213> Artificial Sequence

<220>

<223> Mutant M7-4H

<400> 11

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| Thr | Thr | Glu | Thr | Ile | Gln | Ser | Asn | Ala | Asn | Leu | Ala | Pro | Leu | Pro | Pro |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | |
| His | Val | Pro | Glu | His | Leu | Val | Phe | Asp | Phe | Asp | Met | Tyr | Asn | Pro | Ser |
| | | | 20 | | | | | 25 | | | | | 30 | | |
| Asn | Leu | Ser | Ala | Gly | Val | Gln | Glu | Ala | Trp | Ala | Val | Leu | Gln | Glu | Ser |
| | | 35 | | | | | 40 | | | | | 45 | | | |
| Asn | Val | Pro | Asp | Leu | Val | Trp | Thr | Arg | Cys | Asn | Gly | Gly | His | Trp | Ile |
| | 50 | | | | | 55 | | | | | 60 | | | | |
| Ala | Thr | Arg | Gly | Gln | Leu | Ile | Arg | Glu | Ala | Tyr | Glu | Asp | Tyr | Arg | His |
| 65 | | | | | 70 | | | | | 75 | | | | | 80 |
| Phe | Ser | Ser | Glu | Cys | Pro | Phe | Ile | Pro | Arg | Glu | Ala | Gly | Glu | Ala | Tyr |
| | | | | 85 | | | | | 90 | | | | | 95 | |
| Asp | Phe | Ile | Pro | Thr | Ser | Met | Asp | Pro | Pro | Glu | Gln | Arg | Gln | Phe | Arg |
| | | | 100 | | | | | 105 | | | | | 110 | | |
| Ala | Leu | Ala | Asn | Gln | Val | Val | Gly | Met | Pro | Val | Val | Asp | Lys | Leu | Glu |
| | | 115 | | | | | 120 | | | | | 125 | | | |
| Asn | Arg | Ile | Gln | Glu | Leu | Ala | Cys | Ser | Leu | Ile | Glu | Ser | Leu | Arg | Pro |
| | 130 | | | | | 135 | | | | | 140 | | | | |
| Gln | Gly | Gln | Cys | Asn | Phe | Thr | Glu | Asp | Tyr | Ala | Glu | Pro | Phe | Pro | Ile |
| 145 | | | | | 150 | | | | | 155 | | | | | 160 |
| Arg | Ile | Phe | Met | Leu | Leu | Ala | Gly | Leu | Pro | Glu | Glu | Asp | Ile | Pro | His |
| | | | | 165 | | | | | 170 | | | | | 175 | |
| Leu | Lys | Tyr | Leu | Thr | Asp | Gln | Met | Thr | Arg | Pro | Asp | Gly | Ser | Met | Thr |
| | | | 180 | | | | | 185 | | | | | 190 | | |
| Phe | Ala | Glu | Ala | Lys | Glu | Ala | Leu | Tyr | Asp | Tyr | Leu | Ile | Pro | Ile | Ile |
| | | 195 | | | | | 200 | | | | | 205 | | | |
| Glu | Gln | Arg | Arg | Gln | Lys | Pro | Gly | Thr | Asp | Ala | Ile | Ser | Ile | Val | Ala |
| | 210 | | | | | 215 | | | | | 220 | | | | |
| Asn | Gly | Gln | Val | Asn | Gly | Arg | Pro | Ile | Thr | Ser | Asp | Glu | Ala | Lys | Arg |
| 225 | | | | | 230 | | | | | 235 | | | | | 240 |
| Met | Cys | Gly | Leu | Leu | Leu | Val | Gly | Gly | Leu | Asp | Thr | Val | Val | Asn | Phe |
| | | | | 245 | | | | | 250 | | | | | 255 | |
| Leu | Ser | Phe | Ser | Met | Glu | Phe | Leu | Ala | Lys | Ser | Pro | Glu | His | Arg | Gln |
| | | | 260 | | | | | 265 | | | | | 270 | | |
| Glu | Leu | Ile | Glu | Arg | Pro | Glu | Arg | Ile | Pro | Ala | Ala | Cys | Glu | Glu | Leu |
| | | 275 | | | | | 280 | | | | | 285 | | | |
| Leu | Arg | Arg | Phe | Ser | Leu | Val | Ala | Asp | Gly | Arg | Ile | Leu | Thr | Ser | Asp |
| | 290 | | | | | 295 | | | | | 300 | | | | |
| Tyr | Glu | Phe | His | Gly | Val | Gln | Leu | Lys | Lys | Gly | Asp | Gln | Ile | Leu | Leu |
| 305 | | | | | 310 | | | | | 315 | | | | | 320 |
| Pro | Gln | Met | Leu | Ser | Gly | Leu | Asp | Glu | Arg | Lys | Asn | Ala | Cys | Pro | Met |
| | | | | 325 | | | | | 330 | | | | | 335 | |
| His | Val | Asp | Phe | Ser | Arg | Gln | Lys | Val | Ser | His | Thr | Thr | Phe | Gly | His |
| | | | 340 | | | | | 345 | | | | | 350 | | |
| Gly | Ser | His | Leu | Cys | Leu | Gly | Gln | His | Leu | Ala | Arg | Arg | Glu | Ile | Ile |
| | | 355 | | | | | 360 | | | | | 365 | | | |
| Val | Thr | Leu | Lys | Glu | Trp | Leu | Thr | Arg | Ile | Pro | Asp | Phe | Ser | Ile | Ala |

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| | | |
|---|-----|-----|
| 370 | 375 | 380 |
| Pro Gly Ala Gln Ile Gln His Lys Ser Gly Ile Val Ser Gly Val Gln | | |
| 385 | 390 | 395 |
| Ala Leu Pro Leu Val Trp Asp Pro Ala Thr Thr Lys Ala Val | | 400 |
| 405 | 410 | |

<210> 12
 <211> 414
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Mutant M7-6H

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| His Val Pro Glu His Leu Val Phe Asp Phe Asp Met Tyr Asn Pro Ser | |
| 20 25 30 | |
| Asn Leu Ser Ala Gly Val Gln Glu Ala Trp Ala Val Leu Gln Glu Ser | |
| 35 40 45 | |
| Asn Val Pro Asp Leu Val Trp Thr Arg Cys Asn Gly Gly His Trp Ile | |
| 50 55 60 | |
| Ala Thr Arg Gly Gln Leu Ile Arg Glu Ala Tyr Glu Asp Tyr Arg His | |
| 65 70 75 80 | |
| Phe Ser Ser Glu Cys Pro Phe Ile Pro Arg Glu Ala Gly Glu Ala Tyr | |
| 85 90 95 | |
| Asp Phe Ile Pro Thr Ser Met Asp Pro Pro Glu Gln Arg Gln Phe Arg | |
| 100 105 110 | |
| Ala Leu Ala Asn Gln Val Val Gly Met Pro Val Val Asp Lys Leu Glu | |
| 115 120 125 | |
| Asn Arg Ile Gln Glu Leu Ala Cys Ser Leu Ile Glu Ser Leu Arg Pro | |
| 130 135 140 | |
| Gln Gly Gln Cys Asn Phe Thr Glu Asp Tyr Ala Glu Pro Phe Pro Ile | |
| 145 150 155 160 | |
| Arg Ile Phe Met Leu Leu Ala Gly Leu Pro Glu Glu Asp Ile Pro His | |
| 165 170 175 | |
| Leu Lys Tyr Leu Thr Asp Gln Met Thr Arg Pro Asp Gly Ser Met Thr | |
| 180 185 190 | |
| Phe Ala Glu Ala Lys Glu Ala Leu Tyr Asp Tyr Leu Ile Pro Ile Ile | |
| 195 200 205 | |
| Glu Gln Arg Arg Gln Lys Pro Gly Thr Asp Ala Ile Ser Ile Val Ala | |
| 210 215 220 | |
| Asn Gly Gln Val Asn Gly Arg Pro Ile Thr Ser Asp Glu Ala Lys Arg | |
| 225 230 235 240 | |
| Met Cys Gly Leu Leu Val Gly Gly Leu Asp Thr Val Val Asn Phe | |
| 245 250 255 | |
| Leu Ser Phe Ser Met Glu Phe Leu Ala Lys Ser Pro Glu His Arg Gln | |
| 260 265 270 | |
| Glu Leu Ile Glu Arg Pro Glu Leu Ile Pro Ala Ala Cys Glu Glu Leu | |
| 275 280 285 | |
| Leu Arg Arg Phe Ser Leu Val Ala Asp Gly Arg Ile Leu Thr Ser Asp | |
| 290 295 300 | |

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| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Tyr | Glu | Phe | His | Gly | Val | Gln | Leu | Lys | Lys | Gly | Asp | Gln | Ile | Leu | Leu |
| 305 | | | | | 310 | | | | | 315 | | | | | 320 |
| Pro | Gln | Met | Leu | Ser | Gly | Leu | Asp | Glu | Arg | Lys | Asn | Ala | Cys | Pro | Met |
| | | | | 325 | | | | | 330 | | | | | 335 | |
| His | Val | Asp | Phe | Ser | Arg | Gln | Lys | Val | Ser | His | Thr | Thr | Phe | Gly | His |
| | | | 340 | | | | | 345 | | | | | 350 | | |
| Gly | Ser | His | Leu | Cys | Leu | Gly | Gln | His | Leu | Ala | Arg | Arg | Glu | Ile | Ile |
| | | 355 | | | | | 360 | | | | | 365 | | | |
| Val | Thr | Leu | Lys | Glu | Trp | Leu | Thr | Arg | Ile | Pro | Asp | Phe | Ser | Ile | Ala |
| | 370 | | | | | 375 | | | | | 380 | | | | |
| Pro | Gly | Ala | Gln | Ile | Gln | His | Lys | Ser | Gly | Ile | Val | Ser | Gly | Val | Gln |
| 385 | | | | | 390 | | | | | 395 | | | | | 400 |
| Ala | Leu | Pro | Leu | Val | Trp | Asp | Pro | Ala | Thr | Thr | Lys | Ala | Val | | |
| | | | | 405 | | | | | 410 | | | | | | |

<210> 13
 <211> 414
 <212> PRT
 <213> Artificial Sequence

<220>
 <223> Mutant M7-8H

| | | | | | | | | | | | | | | | |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <400> 13 | | | | | | | | | | | | | | | |
| Thr | Thr | Glu | Thr | Ile | Gln | Ser | Asn | Ala | Asn | Leu | Ala | Pro | Leu | Pro | Pro |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | |
| His | Val | Pro | Glu | His | Leu | Val | Phe | Asp | Phe | Asp | Met | Tyr | Asn | Pro | Ser |
| | | | 20 | | | | | 25 | | | | | 30 | | |
| Asn | Leu | Ser | Ala | Gly | Val | Gln | Glu | Ala | Trp | Ala | Val | Leu | Gln | Glu | Ser |
| | | 35 | | | | | 40 | | | | | 45 | | | |
| Asn | Val | Pro | Asp | Leu | Val | Trp | Thr | Arg | Cys | Asn | Gly | Gly | His | Trp | Ile |
| | 50 | | | | | 55 | | | | | 60 | | | | |
| Ala | Thr | Arg | Gly | Gln | Leu | Ile | Arg | Glu | Ala | Tyr | Glu | Asp | Tyr | Arg | His |
| 65 | | | | 70 | | | | | | 75 | | | | | 80 |
| Phe | Ser | Ser | Glu | Cys | Pro | Phe | Ile | Pro | Arg | Glu | Ala | Gly | Glu | Ala | Tyr |
| | | | | 85 | | | | | 90 | | | | | 95 | |
| Asp | Phe | Ile | Pro | Thr | Ser | Met | Asp | Pro | Pro | Glu | Gln | Arg | Gln | Phe | Arg |
| | | | 100 | | | | | 105 | | | | | 110 | | |
| Ala | Leu | Ala | Asn | Gln | Val | Val | Gly | Met | Pro | Val | Val | Asp | Lys | Leu | Glu |
| | | 115 | | | | | 120 | | | | | 125 | | | |
| Asn | Arg | Ile | Gln | Glu | Leu | Ala | Cys | Ser | Leu | Ile | Glu | Ser | Leu | Arg | Pro |
| | 130 | | | | | 135 | | | | | 140 | | | | |
| Gln | Gly | Gln | Cys | Asn | Phe | Thr | Glu | Asp | Tyr | Ala | Glu | Pro | Phe | Pro | Ile |
| 145 | | | | 150 | | | | | | 155 | | | | | 160 |
| Arg | Ile | Phe | Met | Leu | Leu | Ala | Gly | Leu | Pro | Glu | Glu | Asp | Ile | Pro | His |
| | | | 165 | | | | | | 170 | | | | | 175 | |
| Leu | Lys | Tyr | Leu | Thr | Asp | Gln | Met | Thr | Arg | Pro | Asp | Gly | Ser | Met | Thr |
| | | | 180 | | | | | 185 | | | | | 190 | | |
| Phe | Ala | Glu | Ala | Lys | Glu | Ala | Leu | Tyr | Asp | Tyr | Leu | Ile | Pro | Ile | Ile |
| | | 195 | | | | | 200 | | | | | 205 | | | |
| Glu | Gln | Arg | Arg | Gln | Lys | Pro | Gly | Thr | Asp | Ala | Ile | Ser | Ile | Val | Ala |
| | 210 | | | | | 215 | | | | | 220 | | | | |
| Asn | Gly | Gln | Val | Asn | Gly | Arg | Pro | Ile | Thr | Ser | Asp | Glu | Ala | Lys | Arg |

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| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 225 | | | | | 230 | | | | | 235 | | | | | 240 |
| Met | Phe | Gly | Leu | Leu | Leu | Val | Gly | Gly | Leu | Asp | Thr | Val | Val | Asn | Phe |
| | | | | 245 | | | | | 250 | | | | | 255 | |
| Leu | Ser | Phe | Ser | Met | Glu | Phe | Leu | Ala | Lys | Ser | Pro | Glu | His | Arg | Gln |
| | | | 260 | | | | | 265 | | | | | 270 | | |
| Glu | Leu | Ile | Glu | Arg | Pro | Glu | Arg | Ile | Pro | Ala | Ala | Cys | Glu | Glu | Leu |
| | | 275 | | | | | 280 | | | | | 285 | | | |
| Leu | Arg | Arg | Phe | Ser | Leu | Val | Ala | Asp | Gly | Arg | Ile | Leu | Thr | Ser | Asp |
| | 290 | | | | | 295 | | | | | 300 | | | | |
| Tyr | Glu | Phe | His | Gly | Val | Gln | Leu | Lys | Lys | Gly | Asp | Gln | Ile | Leu | Leu |
| 305 | | | | | 310 | | | | | 315 | | | | | 320 |
| Pro | Gln | Met | Leu | Ser | Gly | Leu | Asp | Glu | Arg | Lys | Asn | Ala | Cys | Pro | Met |
| | | | | 325 | | | | | 330 | | | | | 335 | |
| His | Val | Asp | Phe | Ser | Arg | Gln | Lys | Val | Ser | His | Thr | Thr | Phe | Gly | His |
| | | | 340 | | | | | 345 | | | | | 350 | | |
| Gly | Ser | His | Leu | Cys | Leu | Gly | Gln | His | Leu | Ala | Arg | Arg | Glu | Ile | Ile |
| | | 355 | | | | | 360 | | | | | 365 | | | |
| Val | Thr | Leu | Lys | Glu | Trp | Leu | Thr | Arg | Ile | Pro | Asp | Phe | Ser | Ile | Ala |
| | 370 | | | | | 375 | | | | | 380 | | | | |
| Pro | Gly | Ala | Gln | Ile | Gln | His | Lys | Ser | Gly | Ile | Val | Ser | Gly | Val | Gln |
| 385 | | | | | 390 | | | | | 395 | | | | | 400 |
| Ala | Leu | Pro | Leu | Val | Trp | Asp | Pro | Ala | Thr | Thr | Lys | Ala | Val | | |
| | | | | 405 | | | | | 410 | | | | | | |

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 <211> 66
 <212> DNA
 <213> E. coli

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 atggcc 66

<210> 15
 <211> 22
 <212> PRT
 <213> E. coli

<400> 15
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 1 5 10 15
 Ala Gln Pro Ala Met Ala
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 <212> DNA
 <213> Escherichia coli

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 gacacaatcg tcaacgagct cagatccgat cccaggatcg ctgcttcaat attacgtctg 120
 cacttccatg actgcttcgt gaatgggttc gacgctagca tattactgga caacaccacc 180

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| | | | | | | |
|------------|------------|------------|-------------|------------|------------|-----|
| agtttccgca | ctgaaaagga | tgcattcggg | aacgctaaca | gcgccagggg | ctttccagtg | 240 |
| atcgatcgca | tgaaggctgc | cgttgagtc | gcattgcccac | gaacagtcag | ttgtgcagac | 300 |
| ctgctgacta | tagctgcgca | acagagcgtg | actcttgag | gcggaccgtc | ctggagagt | 360 |
| ccgctcggtc | gacgtgactc | cctacaggca | ttcctagatc | tggccaacgc | caacttgctt | 420 |
| gctccattct | tcaccctgcc | ccagctgaag | gatagcttta | gaaacgtggg | tctgaatcgc | 480 |
| tcgagtgacc | ttgtggctct | gtccggagga | cacacatttg | gaaagaacca | gtgtagggtc | 540 |
| atcatggata | ggctctacaa | tttcagcaac | actgggttac | ctgacccac | gctgaacact | 600 |
| acgtatctcc | agacactgag | aggcttgtgc | ccactgaatg | gcaacctcag | tgcactagt | 660 |
| gactttgatc | tgcggacccc | aaccatcttc | gataacaagt | actatgtgaa | tctagaggag | 720 |
| cagaaaggcc | tgatacagag | tgatcaagaa | ctgttttagca | gtccagacgc | cactgacacc | 780 |
| atcccactgg | tgagaagttt | tgctaactct | actcaaacct | tctttaacgc | cttcgtggaa | 840 |
| gccatggacc | gtatgggtaa | cattaccctt | ctgacgggta | cccaaggcca | gattcgtctg | 900 |
| aactgcagag | tggtcaacag | caactct | | | | 927 |

<210> 17

<211> 309

<212> PRT

<213> Escherichia coli

<400> 17

| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Met | Gln | Leu | Thr | Pro | Thr | Phe | Tyr | Asp | Asn | Ser | Cys | Pro | Asn | Val | Ser |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | |
| Asn | Ile | Val | Arg | Asp | Thr | Ile | Val | Asn | Glu | Leu | Arg | Ser | Asp | Pro | Arg |
| | | | 20 | | | | | 25 | | | | | 30 | | |
| Ile | Ala | Ala | Ser | Ile | Leu | Arg | Leu | His | Phe | His | Asp | Cys | Phe | Val | Asn |
| | | 35 | | | | | 40 | | | | | 45 | | | |
| Gly | Cys | Asp | Ala | Ser | Ile | Leu | Leu | Asp | Asn | Thr | Thr | Ser | Phe | Arg | Thr |
| | 50 | | | | | 55 | | | | | 60 | | | | |
| Glu | Lys | Asp | Ala | Phe | Gly | Asn | Ala | Asn | Ser | Ala | Arg | Gly | Phe | Pro | Val |
| 65 | | | | | 70 | | | | | 75 | | | | 80 | |
| Ile | Asp | Arg | Met | Lys | Ala | Ala | Val | Glu | Ser | Ala | Cys | Pro | Arg | Thr | Val |
| | | | | 85 | | | | | 90 | | | | | 95 | |
| Ser | Cys | Ala | Asp | Leu | Leu | Thr | Ile | Ala | Ala | Gln | Gln | Ser | Val | Thr | Leu |
| | | | 100 | | | | | 105 | | | | | 110 | | |
| Ala | Gly | Gly | Pro | Ser | Trp | Arg | Val | Pro | Leu | Gly | Arg | Arg | Asp | Ser | Leu |
| | | 115 | | | | | 120 | | | | | 125 | | | |
| Gln | Ala | Phe | Leu | Asp | Leu | Ala | Asn | Ala | Asn | Leu | Pro | Ala | Pro | Phe | Phe |
| | 130 | | | | | 135 | | | | | 140 | | | | |
| Thr | Leu | Pro | Gln | Leu | Lys | Asp | Ser | Phe | Arg | Asn | Val | Gly | Leu | Asn | Arg |
| 145 | | | | | 150 | | | | | 155 | | | | 160 | |
| Ser | Ser | Asp | Leu | Val | Ala | Leu | Ser | Gly | Gly | His | Thr | Phe | Gly | Lys | Asn |
| | | | | 165 | | | | | 170 | | | | | 175 | |
| Gln | Cys | Arg | Phe | Ile | Met | Asp | Arg | Leu | Tyr | Asn | Phe | Ser | Asn | Thr | Gly |
| | | | 180 | | | | | 185 | | | | | 190 | | |
| Leu | Pro | Asp | Pro | Thr | Leu | Asn | Thr | Thr | Tyr | Leu | Gln | Thr | Leu | Arg | Gly |
| | | 195 | | | | | 200 | | | | | 205 | | | |
| Leu | Cys | Pro | Leu | Asn | Gly | Asn | Leu | Ser | Ala | Leu | Val | Asp | Phe | Asp | Leu |
| | 210 | | | | | 215 | | | | | 220 | | | | |
| Arg | Thr | Pro | Thr | Ile | Phe | Asp | Asn | Lys | Tyr | Tyr | Val | Asn | Leu | Glu | Glu |
| 225 | | | | | 230 | | | | | 235 | | | | 240 | |
| Gln | Lys | Gly | Leu | Ile | Gln | Ser | Asp | Gln | Glu | Leu | Phe | Ser | Ser | Pro | Asp |
| | | | | 245 | | | | | 250 | | | | | 255 | |
| Ala | Thr | Asp | Thr | Ile | Pro | Leu | Val | Arg | Ser | Phe | Ala | Asn | Ser | Thr | Gln |

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| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | | 260 | | | | | 265 | | | | 270 | | | |
| Thr | Phe | Phe | Asn | Ala | Phe | Val | Glu | Ala | Met | Asp | Arg | Met | Gly | Asn | Ile |
| | | 275 | | | | | 280 | | | | | 285 | | | |
| Thr | Pro | Leu | Thr | Gly | Thr | Gln | Gly | Gln | Ile | Arg | Leu | Asn | Cys | Arg | Val |
| | 290 | | | | | 295 | | | | | 300 | | | | |
| Val | Asn | Ser | Asn | Ser | | | | | | | | | | | |
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<220>
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